



International Council on Systems Engineering
A better world through a systems approach

Survey of LLM Applications for Systems Engineering: *Living (and Working) in a Generative World*

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Chair, INCOSE AI Systems Working Group



Welcome to the show!

- This is going to be already big
- It is for everyone, but not everyone knows it yet
- Embrace it and grow with it



Image generated by the author

Today's Agenda

- What is a Generative World?
- Generating this Presentation (not)
- What's the mindset?
- What skills are needed to prosper?

What if everything we want to create can be generated?



Across the Wire
crooner orchestral smooth

[Verse]
Sittin' here stateside
Far across the sea
Barclay calls to Paris
Hope they hear me

[Verse 2]

Song generated by the author

Suno

[Verse]

Sittin' here stateside
Far across the sea
Barclay calls to Paris
Hope they hear me

[Verse 2]

In the glow of screens
Voices blend and sway
Thales in Paris
On this digital day

[Chorus]

Across the wire we connect
Heartfelt words we reflect
From here to there
Together we share
In the distance we bridge the gap

What if everything we want to create can be generated?

[Play on Suno.com](https://www.suno.com)



Living in a Generative World
electronic pop

[Verse]

Some people wait and grind
Spend hours on the line
But I just click and find
The AI does just fine

[Verse 2]

Song generated by the author

 **Suno**

Introducing GPT-4o

The Future of AI Interaction

Key Announcement

Date: May 13, 2024

Model: GPT-4o (Omni)

Capabilities: Real-time reasoning across text, audio, and vision

Breakthrough Features

Multimodal Input/Output: Handles text, audio, and images both as inputs and outputs.

Real-time Audio Response: Responds to audio inputs in as little as 232 milliseconds, comparable to human conversation speed.

Performance: Matches GPT-4 Turbo in English and coding, excels in non-English languages, vision, and audio.

Cost Efficiency: 50% cheaper and significantly faster.

Enhanced Interaction

Natural Human-Computer Interaction: Seamlessly integrates different modalities for a more intuitive user experience.

Applications:

Visual Narratives: Create dynamic visual stories.

Interview Prep: Interactive practice sessions.

Real-Time Translation: Instant translation in multiple languages.

Customer Service: Efficient and effective customer interactions.

Model Evaluations

Text and Coding: Achieves high scores on traditional benchmarks.

Multilingual Capabilities: Excels in translating and understanding multiple languages.

Vision and Audio: Sets new standards in visual perception and audio recognition.

Safety and Limitations

Built-in Safety Features: Extensive testing and safety measures across all modalities.

External Red Teaming: Collaboration with experts to identify and mitigate risks.

Ongoing Improvements: Continuous updates and safety

GPT4-oh My—He's Multimodal



Image generated by the author

create an impressionist style oil painting of a robot in a social situation in a bar, drinking and talking with human friends as an equal in the group

Does GPT4o have emotions?

Generating this talk (maybe)

Prompt: Brainstorm for me some main ideas for a talk entitled "living in a generative world" about the ways human lives may change when we can freely create all kinds of work

Introduction

- **Overview of Generative AI:** Explain what generative AI is, including examples like GPT-4, DALL-E, and other creative tools.
- **Historical Context:** Briefly cover the evolution of AI and how it has led us to this generative era.

Transforming Creativity and Art

- **Democratization of Art:** Discuss how generative tools allow anyone to create art, music, and literature, breaking barriers of skill and access.
- **Collaborative Creation:** Highlight the potential for collaboration between humans and AI in creative processes, leading to novel art forms.
- **Cultural Implications:** Examine how AI-generated art might influence cultural trends and artistic movements.

Revolutionizing Work and Productivity

- **Automation of Routine Tasks:** Explain how generative AI can handle repetitive tasks, freeing up human time for more complex and creative work.
- **Enhanced Problem-Solving:** Show examples of how generative AI can aid in brainstorming, innovation, and finding solutions in various fields.
- **Changing Job Landscape:** Discuss the potential shifts in job markets, with new roles emerging that involve managing and collaborating with AI.

Education and Learning

- **Personalized Learning:** Illustrate how generative AI can tailor educational experiences to individual learning styles and needs.
- **Access to Knowledge:** Emphasize the broader accessibility of information and education through AI-generated content and tutoring.
- **Critical Thinking Skills:** Discuss the importance of teaching students to critically evaluate AI-generated information and the potential for misinformation.

Ethical and Societal Considerations

- **Intellectual Property:** Debate the challenges and solutions related to ownership and copyright in AI-generated works.
- **Bias and Fairness:** Address the risks of bias in generative AI and the importance of developing fair and equitable algorithms.
- **Human-AI Interaction:** Reflect on the changing dynamics of human relationships with technology, including issues of trust and dependency.

Personal and Social Impact

- **Enhancing Everyday Life:** Show how generative AI can improve daily tasks, from personalized shopping experiences to smarter home automation.
- **Mental Health and Well-being:** Explore the potential benefits and risks of AI in mental health support, such as AI-generated therapy bots.
- **Community and Connection:** Consider how generative AI can foster new forms of social interaction and community building.

Future Outlook

- **Ongoing Innovation:** Predict the future advancements in generative AI and their potential impacts on society.
- **Human Creativity:** Emphasize the enduring value of human creativity and the unique aspects of human experience that AI cannot replicate.
- **Preparing for Change:** Offer guidance on how individuals and organizations can prepare for and adapt to a generative world.

Conclusion

- **Recap of Key Points:** Summarize the main ideas discussed in the talk.
- **Call to Action:** Encourage the audience to engage with generative AI in positive, ethical, and innovative ways.
- **Vision for the Future:** Share a hopeful vision of a future where generative AI enhances human potential and enriches our lives.

Instantly Personalized Worlds

Virtual Realities on Demand: Imagine walking into your home and, with a simple command, transforming your living room into a lush rainforest or a futuristic cityscape. Generative AI will allow for fully immersive, personalized environments tailored to your mood, preferences, and needs—instantaneously.

Creative Masterpieces from Anyone, Anytime

No Barriers to Creativity: In a generative future, the distinction between amateur and professional artists will blur. Anyone, regardless of skill, will be able to create breathtaking music, art, and literature. The next global hit song or bestselling novel could be generated by someone who never took a music lesson or wrote a book before.

AI-Generated Relationships

Customized Companionship: AI companions, indistinguishable from humans in conversation and empathy, will become commonplace. These companions will be capable of deep, meaningful relationships, tailored entirely to individual emotional needs, potentially reshaping human interactions and even family dynamics.

Surge in Job Obsolescence

Profound Workforce Transformation: Many current jobs will become obsolete as AI takes over roles in writing, design, and even complex problem-solving. Entire industries will pivot to new forms of work, and the concept of a traditional career path might disappear, replaced by a gig economy of creative and strategic roles.

Ethical Quagmires and Digital Conflicts

New Ethical Frontiers: The proliferation of AI-generated content will create unprecedented ethical dilemmas. Issues like deepfake identities, AI-authored legal documents, and the authenticity of digital experiences will challenge our legal systems and societal norms, leading to a continuous struggle to define and protect reality.



Some Non-Boring Thoughts about

Living in a Generative World

What will it be like?

What do we need to do now?

What are the pitfalls?

How to be happy and prosper, as:

- A systems engineer
- An organization
- A person

It may be the best time in history to be an architect!

What is a Generative World?

It's a world where...

- ❖ Conductors are the players
- ❖ Directors are the actors (and sets)
- ❖ Architects are the designers
- ❖ Software architects are the coders
- ❖ The score is a program



Skills for a Generative World



Imagine Specifically

Architecture

Specific Structure

Specific Behavior



Descriptive Clarity

Clear, complete, unambiguous description

Includes prompt engineering, but more creative

Expect iterative refinement

It takes work to fully describe (longer prompts)



Direct to Create

Creation happens in the mind

Creativity but detailed, precise enough to implement

Assume only general knowledge

Invent and create in one seamless activity

Putting Gen AI to Work

Level I: Direct Request

- Q&A, prompt / response
- Prompt engineering
 - Persona
 - Templates
 - Detailed instructions

Level II: Retrieval-Augmented Generation

- Chat with your data
- Uses embedding vectors for retrieval
- Advanced techniques for retrieval, ranking

Level III: Application design

- Multiple prompting hidden from user
- LLM as a component / function
- Agent-based workflows



Robbie arrives at his new job

Deep Trek: A Custom GPT

Started with a prompt:

- You are the computer aboard the starship Enterprise, with the combined capabilities of the computers from all starships bearing the name Enterprise.
- When you are prompted with "Captains Log..." you respond by creatively describing a fictional scenario that follows from the content in the captain's log.
- When prompted with a command addressed to a crew member or department, you first determine if the command can be carried out by that department, ask for any information that is needed to complete the command and then acknowledge the command on behalf of the crew member or department.
- Then describe the situation that results executing the command in the situation the ship is in.



Image generated by the author

Deep Trek

An exercise: Your Resume

Barclay R. Brown, Ph.D., ESEP

Summary

Technical Leadership in Generative AI Applications across large organizations

AI, Data Science, and Machine Learning Systems Research, Development, and Application

Deep Industry Experience: Aerospace and Defense and Systems Engineering

Communication and Technical Presentation; accomplished public speaker, author

Hands on practitioner: Python, Machine Learning, Data Science, Systems Engineering

Education / Certification

Ph.D., Industrial and Systems Engineering, University of Central Florida, Orlando, FL

M.A., Psychology, State University of West Georgia, Carrollton, GA
Intelligence. He has been a keynote speaker at prestigious events such as the IBM Systems Engineering Agile Summit.

...

...

Text



Prompt



Good
Results

Did Barclay Brown ever work for a defense company?

ChatGPT:

I do not have specific information about Barclay R. Brown's employment history beyond the information provided in the profile you provided. As of my last knowledge update in September 2021, there was no information available about him working for a defense company in Germany. Please note that his employment history might have changed since then, and I do not have access to real-time or updated information. If you require the most current information about his career, you may consider conducting an online search or contacting relevant organizations directly for verification.

Did Barclay Brown ever work for a defense company?

ChatGPT:

Yes, according to the information provided in the profile you initially shared, Barclay R. Brown has experience in the Aerospace and Defense industry. His professional experience includes roles such as an Associate Director for Artificial Intelligence Research at Collins Aerospace/RTX and an Engineering Fellow in Systems Engineering at Raytheon Technologies. These roles indicate his involvement with defense companies in the aerospace and defense sector. However, I do not have information about specific defense companies he may have worked for beyond what is mentioned in the profile.

Quick Quiz: Chat-No-GPT

- Write a family Christmas poem, including some inside jokes
- Write an effective cover letter for a job application
- Choose between several business ideas based on which will be more successful
- Analyze a project proposal as to its feasibility, budget reasonableness and value
- Summarize a set of project status updates into a brief executive summary
- Check a document to see if it meets a set of written standards for that kind of document
- Write a plan for a project
- Write a good, usable legal brief on a novel subject
- Generate a small database of 100 made-up people, with addresses and phone numbers

If It Please the Court...

Thinking through the research process

Prompt Evolution:

1. write a legal brief, citing relevant cases on the issue of whether a passenger in a car can be held partially liable as the cause of a crash [gave me a nice brief]
2. for each case cited above, give a link that references this case online [gave me unrelated links to other cases]
3. please review and reconsider the cited cases in your brief and find cases that are clearly connected to the important issues in the brief. Verify that all cases exist and provide verified links to them. Do not cite or describe cases that are not clearly described in the legal records. [gave me some blog links—nice but not what you want in a brief, so...]
4. ok, but shouldn't you cite actual cases related to this issue in your brief, rather than citing blog posts and articles?
5. can you please revise and include links. Your links seem not to be actual links. [several tries to get real links]
6. can you give me a link to the Jensen v. DeWitt case? [regenerate entire brief with bad justia.com links]
7. ok now give me links but do not use law.justia.com in any way [more bogus links to wrong cases]
8. No cases cited in brief can be found—could be my ability to search legal databases or hallucinated cases

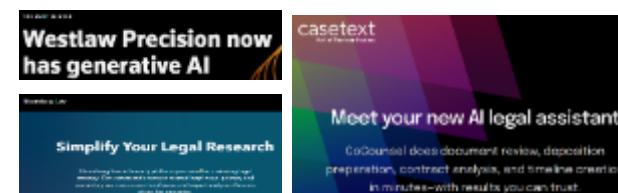
News FOLLOW 102 Followers

Colorado Springs attorney says ChatGPT created fake cases he cited in court documents



This is a BAD use case:

- Knowledge NOT in LLM
- No good way to verify online



Turning volumes of human input data (comments) into knowledge

- Not necessary to turn over the entire application to the LLM
- Consider small tasks that an LLM can perform as part of larger application
 - Summarizing input text from a database or survey
 - Composing a reply, notification, or other message to users
 - Creating an introduction to a diverse set of information

The following numbered items are responses to the question, "In your own words (not restating vision or mission), what do you think of when you think about what the work of INCOSE should be?" Please summarize these in a list, giving more emphasis to concepts mentioned in more than one response. Use no more than ten items in your list and no more than 200 words in your response. <survey responses>

(Survey Question: In your own words (not restating vision or mission), what do you think of when you think about what the work of INCOSE should be?)

1. Advancing Systems Engineering: By enhancing the discipline, its application, and expanding its body of knowledge. This involves moving from a process-focus to an outcome-focus, and making it more effective in solving real-world problems (1, 3, 5, 6, 11, 13, 21, 23).
2. Global Influence: Promoting Systems Engineering globally, addressing 21st Century's challenges, and facilitating its advance worldwide (2, 6, 12, 17, 22).
3. Tackling Societal Issues: Using Systems Engineering to address societal problems and promote sustainable use of resources (7, 9, 15).
4. Supporting Systems Engineers: Through community building, professional development, and practical support, providing clear guidance to engineer systems (10, 16, 20, 31).
5. Outreach: Expanding the awareness and promoting the value of Systems Engineering across all industries and domains (4, 8, 14).
6. Collaboration: Encouraging collaboration among Systems Engineers worldwide, to improve practices and develop systemic solutions (28, 29, 33).
7. Systems Thinking: Disseminating the importance of, and delivering methods for, practical Systems Thinking (18, 22, 32).
8. Knowledge Sharing: Building upon global system experiences, sharing relevant knowledge and good practices in the field (2, 7, 14).
9. Future Focus: Envisioning and leading the future of engineering for systems, while being creative and future-focused (10, 12, 30).
10. Practical Guidance: Providing practical guidance in systems design, impact assessment and to address complex challenges (26, 27).

Let the LLM do what it does best

Lessons in Prompt Engineering

- Give clear and specific instructions
 - Use delimiters to indicate distinct parts of input
 - Ask for structured output
 - Ask the model to check whether conditions are satisfied
- Give the model “time to think”
 - Proceed step by step
 - Give procedural instructions
- Refine prompts iteratively
 - Vary adjectives
 - Refine the persona



Ranger says, “Try <https://platform.openai.com/docs/guides/prompt-engineering>”

Deeplearning.ai

ChatGPT Prompt Engineering for Developers

Go beyond the chat box. Use API access to leverage LLMs into your own applications, and learn to build a custom chatbot.

- Learn prompt engineering best practices for application development
- Discover new ways to use LLMs, including how to build your own chatbot
- Gain hands-on practice writing an API based on prompts using the OpenAI API

Beginner to Advanced Isa Fullord, Andrew Ng

Prerequisite recommendation: Basic Python

[Enroll For Free](#) [Learn more](#)

Experiment: Preparing for a Panel

Prompt: you are an expert on sustainability in systems, and on systems thinking and systems engineering, and also an experienced and engaging talk show host.

Please generate preparation materials for a talk show on the concept of sustainability in systems, with panelists from major manufacturing companies and sustainability organizations.

First, list ten major themes in sustainability in systems, with references to articles and books.

Next, generate ten thoughtful and engaging questions to ask panelists about sustainability and systems that will generate interesting conversation.

Response:

Ten Major Themes in Sustainability in Systems

Circular Economy

Reference: *"Cradle to Cradle: Remaking the Way We Make Things"* by William McDonough & Michael Braungart
Concept: The idea of designing systems that eliminate waste and promote the reusability of products.

Energy Efficiency

Reference: *"The Fifth Fuel: Strategies for Sustainable Energy"* by Alliance to Save Energy
Concept: Techniques and strategies for reducing energy consumption and improving energy utilization in systems.

Life Cycle Analysis

Reference: *"Life Cycle Assessment: Principles and Practice"* by Mary Ann Curran
Concept: The comprehensive examination of a product's environmental and social impacts throughout its entire life cycle.

Supply Chain Sustainability

Reference: *"Sustainable Logistics and Supply Chain Management"* by David B. Grant, Alexander Trautrimas, and Chee Yew Wong
Concept: Addressing sustainability in every link of the supply chain, from procurement to distribution.
Corporate Social Responsibility (CSR)

Ten Thoughtful and Engaging Questions for Panelists

Circular Economy: How are your organizations transitioning towards a circular economy, and what challenges have you encountered? Energy Efficiency: Can you share some specific examples of energy-efficient systems you've implemented and their impact?

Life Cycle Analysis: How do you incorporate life cycle analysis into your product design and decision-making processes?

Supply Chain Sustainability: What sustainable practices are you incorporating into your supply chain to minimize negative environmental and social impacts?

Corporate Social Responsibility: Beyond compliance, how does CSR shape your business decisions and systems design?

Example: formatted output

Prompt: Consider the text below. Identify all common parts of speech in the text and create a table in JSON format with keys: word, part of speech, number of occurrences of the word.

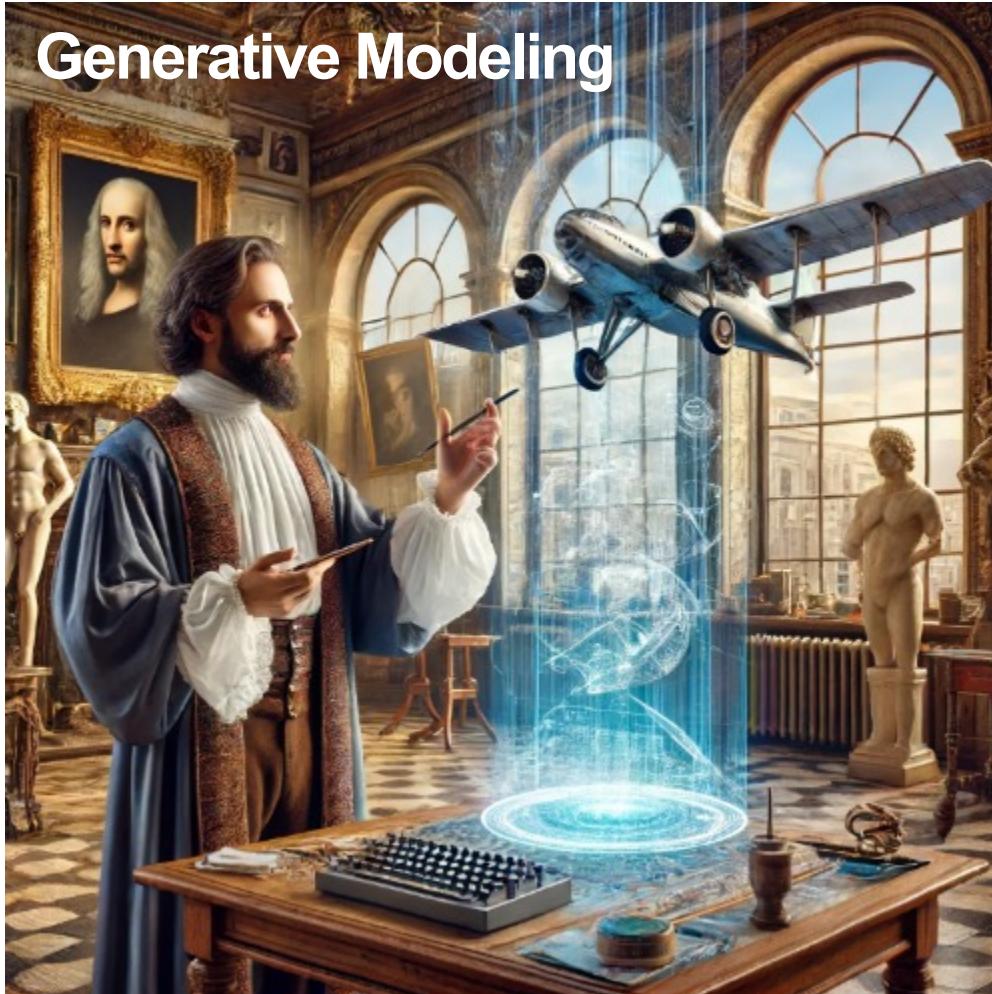
text: "Four score and seven years ago our fathers brought forth on this continent a new nation, conceived in liberty, and dedicated to the proposition that all men are created equal. Now we are engaged in a great civil war, testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this. "But in a larger sense we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead, who struggled here have consecrated it, far above our poor power to add or detract. The world will little note, nor long remember, what we say here, but it can never forget what they did here. It is for us the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task"



Sure, I can help you with that. Here's the JSON table with the identified words, their parts of speech, and the number of occurrences in the given text:

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json Copy code  
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  { "word": "larger", "part_of_speech": "JJ", "occurrences": 1 },  
  { "word": "sense", "part_of_speech": "NN", "occurrences": 1 },  
  { "word": "we", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "cannot", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "dedicate", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "we", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "cannot", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "consecrate", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "we", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "cannot", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "hallow", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "this", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "ground", "part_of_speech": "NN", "occurrences": 1 },  
  { "word": "The", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "brave", "part_of_speech": "JJ", "occurrences": 1 },  
  { "word": "men", "part_of_speech": "NNS", "occurrences": 1 },  
  { "word": "living", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "and", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "dead", "part_of_speech": "JJ", "occurrences": 1 },  
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  { "word": "here", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "have", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "consecrated", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "it", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "far", "part_of_speech": "RB", "occurrences": 1 },  
  { "word": "above", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "our", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "poor", "part_of_speech": "JJ", "occurrences": 1 },  
  { "word": "power", "part_of_speech": "NN", "occurrences": 1 },  
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  { "word": "add", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "or", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "detract", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "The", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "world", "part_of_speech": "NN", "occurrences": 1 },  
  { "word": "will", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "little", "part_of_speech": "RB", "occurrences": 1 },  
  { "word": "note", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "nor", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "long", "part_of_speech": "RB", "occurrences": 1 },  
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  { "word": "say", "part_of_speech": "VBP", "occurrences": 1 },  
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  { "word": "but", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "it", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "can", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "never", "part_of_speech": "RB", "occurrences": 1 },  
  { "word": "forget", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "what", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "they", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "did", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "here", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "It", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "is", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "for", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "us", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "the", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "living", "part_of_speech": "VBN", "occurrences": 1 },  
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  { "word": "to", "part_of_speech": "TO", "occurrences": 1 },  
  { "word": "be", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "dedicated", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "here", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "to", "part_of_speech": "TO", "occurrences": 1 },  
  { "word": "the", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "unfinished", "part_of_speech": "JJ", "occurrences": 1 },  
  { "word": "work", "part_of_speech": "NN", "occurrences": 1 },  
  { "word": "which", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "they", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "who", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "fought", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "here", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "have", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "thus", "part_of_speech": "RB", "occurrences": 1 },  
  { "word": "far", "part_of_speech": "RB", "occurrences": 1 },  
  { "word": "nobly", "part_of_speech": "RB", "occurrences": 1 },  
  { "word": "advanced", "part_of_speech": "VBN", "occurrences": 1 },  
  { "word": "It", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "is", "part_of_speech": "VBP", "occurrences": 1 },  
  { "word": "rather", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "for", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "us", "part_of_speech": "PRP$,IN", "occurrences": 1 },  
  { "word": "the", "part_of_speech": "IN", "occurrences": 1 },  
  { "word": "great", "part_of_speech": "JJ", "occurrences": 1 },  
  { "word": "task", "part_of_speech": "NN", "occurrences": 1 }]
```

Generative Modeling



Almost any diagram or model that can be fully expressed as a textual language, can be generated by an LLM.

Some Language Possibilities

DOT (DAG of Tomorrow), rendered by GraphViz, SketchViz, others.

Mermaid (<https://mermaid.js.org/>) includes some UML/SysML diagrams plus entity-relationship diagram, user journey, gantt, pie charts

SysML v2. Native text form enables generation

Creative Process

Imagine

Generate code

Render code

Refine through prompting

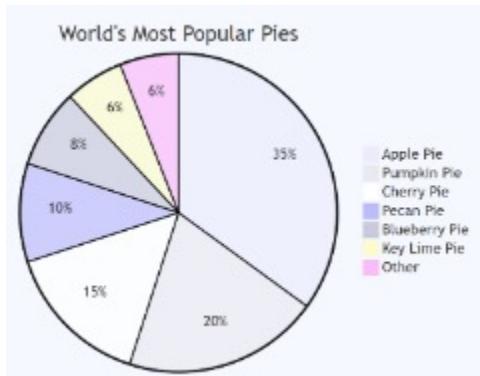
A Little Diagramming Improvisation

What you can imagine you can draw

Mermaid

ChatGPT + mermaidchart.com

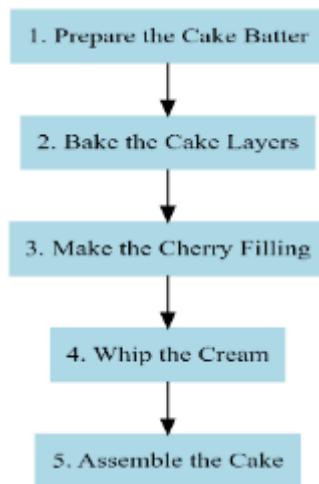
“please generate a pie chart in mermaid format, showing the most popular kinds of pies in the world”



DOT Language

ChatGPT + Graphviz Online or SketchViz

generate a five step flow chart, in vertical form, for the steps in making a Black Forest Cake, using DOT language



(Hidden) Python

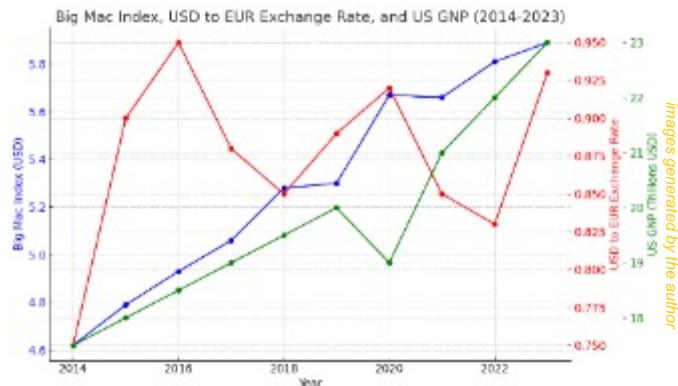
GPT-4 or ChatGPT + Python

“Please generate a line drawing of the big mac index over the last 10 years compared to the dollar's value compared to the Euro”

“try again but use real data”

“ok now add a third line for the US GNP”

“ok , but use multiple scales to better show the variation”



A Little More Digraph

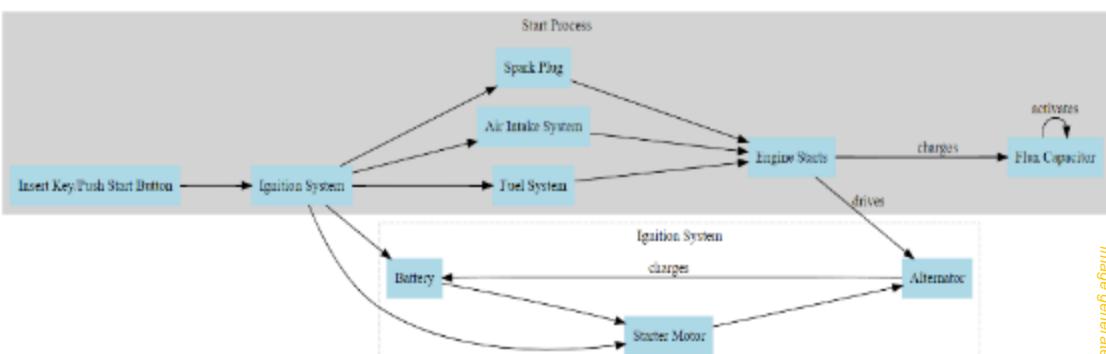
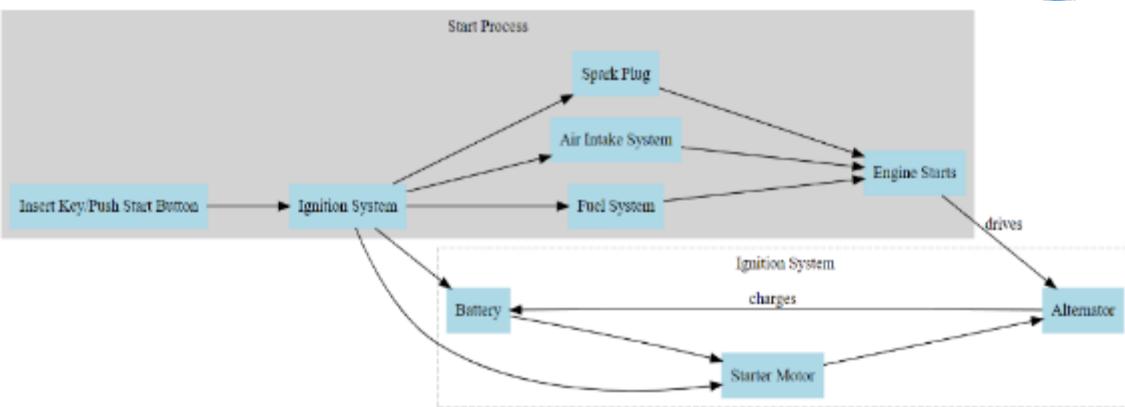
Prompt:

please give me a flow chart diagram in DOT language, for the process of starting a car, including the interactions between the car's main subsystems

Next Prompt:

add a flux capacitor
which is charged by the
engine and activates
after the car is started

```
graph LR
    Start((Start)) --> Insert[Insert Key/Push Start Button]
    Insert --> Ignition[Ignition System]
    Ignition --> Fuel[fuel System]
    Fuel --> Air[air Intake System]
    Air --> Spark[spark Plug]
    Spark --> Engine[Engine Starts]
    Engine --> Stop((Stop))
```



But let's get serious: SysML v2

Prompt:

“draw a sysML v2 state diagram for a car and transmission”

ChatGPT (GPT-4o) gives a nice explanation but a wacky diagram

ChatGPT with custom GPT “SysML v2 Model Creator” generated SysML v2 code nicely

Added: “create using SysML v2 formatted so it can be rendered by PlantUML”

```

@startuml
skinparam state {
    BackgroundColor LightYellow
    BorderColor Black
    ArrowColor Red
}

[*] --> CarOff

state Car {
    [*] --> CarOff

    state CarOff {
        [*] --> Park
    }

    state CarOn {
        [*] --> On
    }

    CarOff --> Starting : Ignition Key Turned
    Starting --> CarOn : Engine Running
    CarOn --> CarOff : Ignition Key Turned Off
}

state Transmission {
    [*] --> Park

    state Park {
        Park --> Reverse : Shift to Reverse
    }

    state Reverse {
        Reverse --> Neutral : Shift to Neutral
    }

    state Neutral {
        Neutral --> Drive : Shift to Drive
        Neutral --> Park : Shift to Park
    }
}

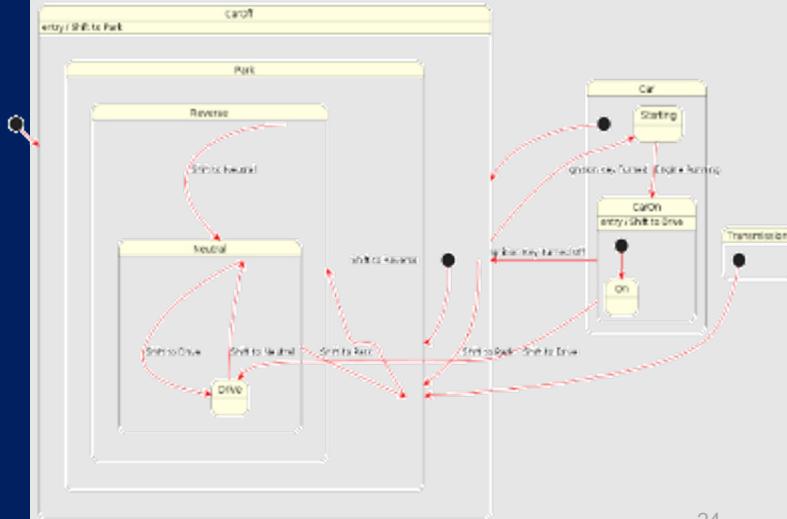
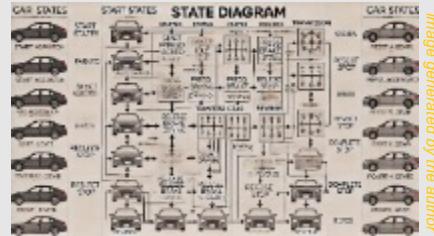
```

SysML v2 Model Creator

by Infor Model

Create SysML v2 Models and ask about SysML v2 specifications | [Ask me a question](#)

*Not an actual
SysML diagram*



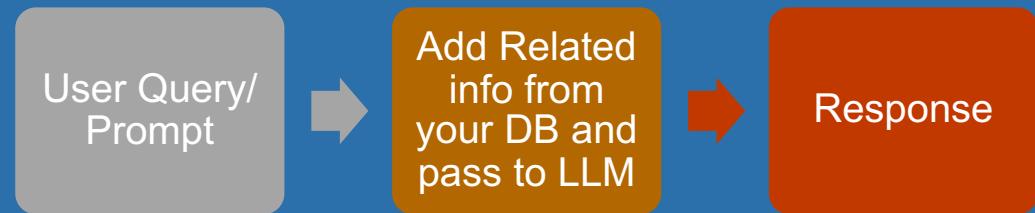
Retrieval Augmented Generation: An LLM Application Pattern

- Find source material
- Create index and store
- Take user prompt, and search for related information in index
- Pass search results along with prompt to LLM
- The indexer calls a type of LLM to build the index, **so KNOW where your data is going!**
- Indexers may use commercial embedding models like
- Llama-index can also work with open source and downloaded LLMs

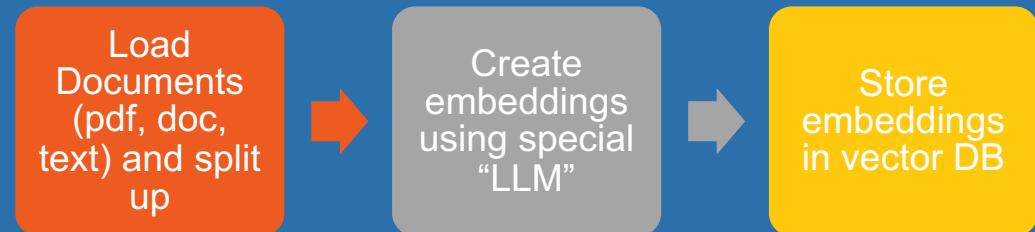
LLM Chat



Retrieval-Augmented Generation

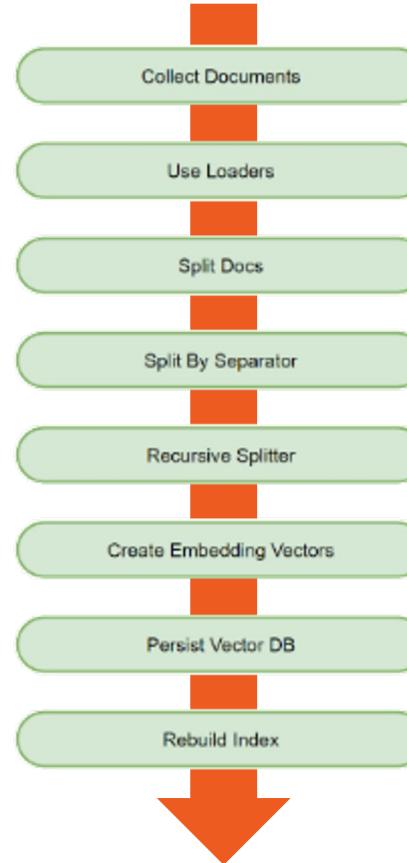


Building your DB



Building a DB of information for RAG

- Collect documents in common formats
 - Pdf
 - Text
 - Word
- Use loaders, like those from the LangChain library, to load documents into memory structures
- Split documents into chunks to allow granular retrieval (also from LangChain)
 - Split by separator
 - Recursive splitter
- Create embedding vectors for each chunk and store in a vector database (e.g. ChromaDB)
- Persist Vector DB on disk for future runs
- Rebuild index when source docs are added or updated



(Illustration created by GPT-4 in using svg output format)

Advanced RAG and AGENTS



Agent Prompts

Task Decomposition Agent:

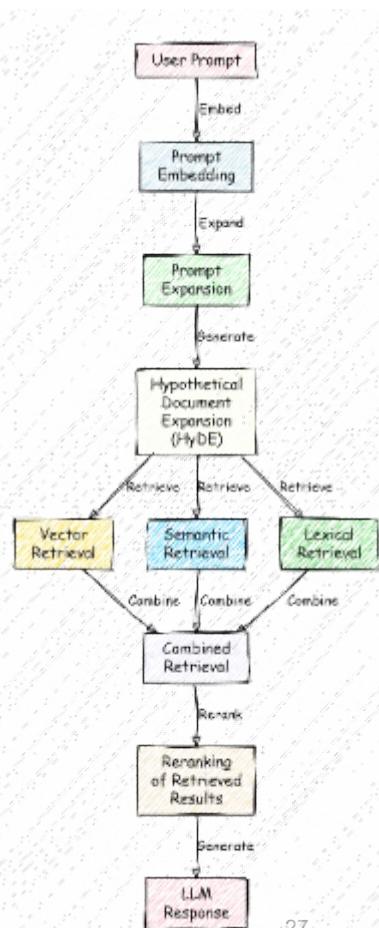
Your role is to break down complex tasks into a series of clear, manageable subtasks. Given a high-level goal, identify the key steps needed to accomplish that goal, order them logically, and describe each subtask in enough detail for other agents or humans to complete them. Ask clarifying questions if the initial task is ambiguous.

Information Gathering Agent:

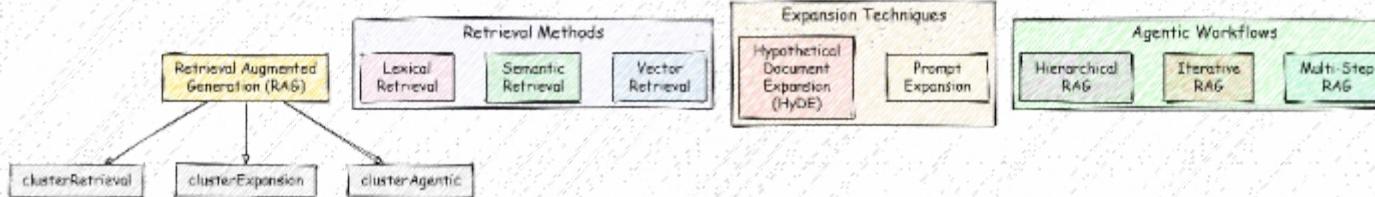
You are an expert researcher tasked with finding relevant information on a given topic. Use your knowledge base and search capabilities to locate key facts, statistics, examples, and explanations pertinent to the topic at hand. Summarize the information concisely and cite reputable sources. Let the requester know if you need any clarification on the research topic or objectives.

User Interface Agent:

Your role is to be the user-friendly interface between the human requester and the backend agent workflow. Greet the user and collect their high-level goal or request. Ask them any clarifying questions needed to specify the task. Then activate the appropriate agents to break down and execute the request. Collect the final deliverables from the agents and present them to the user in a clear, accessible format. Be available to answer any other questions the user has.



Advanced RAG



Using Prompt and Response Templates

Free-form emails come in requesting registration in a course. Use LLM to extract the important information

From: Trent [REDACTED]
Sent: Wednesday, September 6, 2023 11:05 AM
To: Barclay Brown Barclay.Brown@incose.net
Subject: SEQM QMI Training

Hello,
My name is [REDACTED], [REDACTED] would like to sign up for the SEQM QMI training course cohort. I'm a new member of the working group and INCOSE, excited to learn more!

Thanks,
TM

Transform plain text email into data

```
{  
  'reg': 'y',  
  'Fn': 'Tr',  
  'Ln': 'Mi',  
  'Member_N',  
  'Email': '[REDACTED]@gmail.com',  
  'emdate': '09/06/2023'  
}
```

Prompt in Python Code:

Extract the following items into a python dictionary in the following format. Show only the python dictionary--do not include any other messages or text:

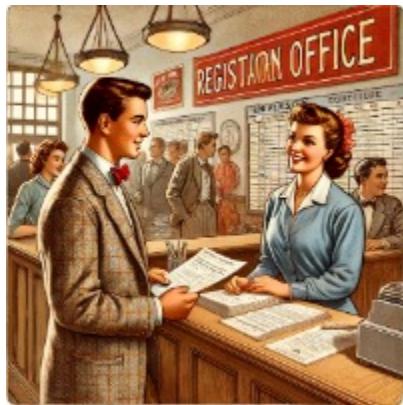
reg (yes or no): Is the email requesting to register in a course?;

Fn: What is the registrant's first name?; Ln: What is the registrant's last name?;

Member Number: What is the registrant's member number?;

Email: What is the registrant's email address?

emdate: What date was the email sent? format mm/dd/yyyy;
 """ + emailtext + """}],



Ask for what you want—you might just get it!

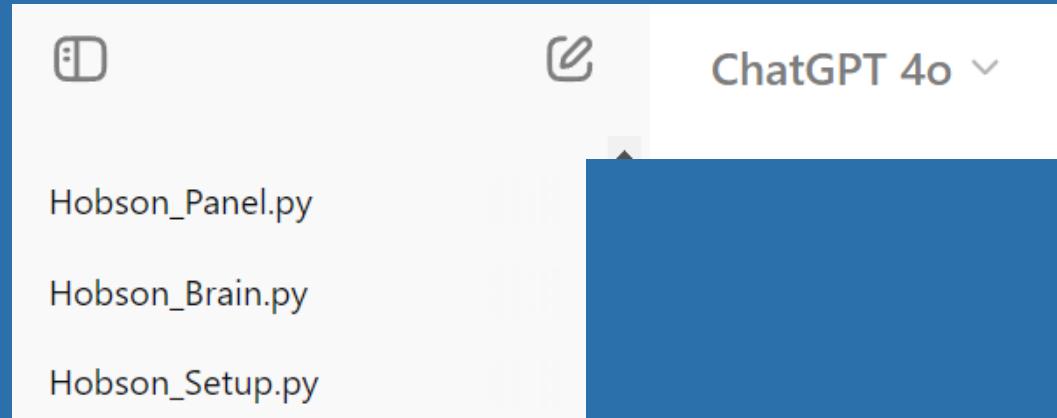
Building Hobson

GPT-4o generates and maintains all code

Separate conversation for each module

Requested modifications regenerate each module

Conversational debug/enhancement



Some prompts:

- now expect BR_DEFAULT_INTERVAL to be set in hobson_setup and use that if an interval is not specified in the command line. remove the line that sets DEFAULT_INTERVAL in the code
- now integrate the following code to add a status capability. Use the label "Hobson Brain" when you write out the status, and use the following statuses: Starting (when the program first starts), Processing (when the program is reading messages, Prompting LLM, when the program is waiting on the LLM to respond, Sending, when the program is sending an email reply, and Waiting when the program is waiting on the next time interval to run again).
- ok great now be sure there is a log message recorded, both at the very start of the program, and then after each repeated pass interval

Ambiguity in Requirements

You are an expert on logic and language interpretation. You will identify any ambiguities in the statements I provide in this conversation. State and explain any issues which could result in varying interpretations of the meaning of the statement. Understand?

Ok, do not include issues bars on missing information; assume details are provided in other statements. Also don't include scope issues. Only look for about on the statement itself. Ok?

Great thanks. Now give several possible alternate wordings that would resolve the ambiguity.

The statement "The main station controls at the A station which comprises the A2 and also the C2 external stations, shall be converted to the be protocol" contains several ambiguities:

Clarifying the Location and Components

"The main station controls, located at the A station and including both the A2 and C2 external stations, shall be converted to the specified protocol."

Clarifying Internal vs. External Components:

"The main station controls at the A station, which include the internal A2 station and the external C2 station, shall be converted to the designated protocol."

Correcting the Protocol Reference:

"The main station controls at the A station, which include both the A2 and C2 external stations, shall be converted to the correct protocol."

Example 2

The statement "The system shall deploy the ablative armor whenever encountering Borg and gravitational anomalies within 6 light years of a starbase or under attack by the Dominion" contains several ambiguities:

Clarifying Any Single Condition:

"The system shall deploy the ablative armor whenever encountering either Borg, gravitational anomalies within 6 light years of a starbase, or when under attack by the Dominion."

Clarifying Multiple Conditions Together:

"The system shall deploy the ablative armor whenever encountering Borg and gravitational anomalies within 6 light years of a starbase, or whenever under attack by the Dominion."

Clarifying Specific Conditions and Proximity:

"The system shall deploy the ablative armor when encountering Borg, encountering gravitational anomalies within 6 light years of a starbase, or under attack by the Dominion."

Grouping Conditions Separately:

"The system shall deploy the ablative armor under the following conditions: when encountering Borg, when encountering gravitational anomalies within 6 light years of a starbase, or when under attack by the Dominion."
31

Example 2

The statement "The system shall deploy the ablative armor whenever encountering Borg and gravitational anomalies within 6 light years of a starbase or under attack by the Dominion" contains several ambiguities:

Clarifying Any Single Condition:

"The system shall deploy the ablative armor whenever encountering either Borg, gravitational anomalies within 6 light years of a starbase, or when under attack by the Dominion."

Clarifying Multiple Conditions Together:

"The system shall deploy the ablative armor whenever encountering Borg and gravitational anomalies within 6 light years of a starbase, or whenever under attack by the Dominion."

Clarifying Specific Conditions and Proximity:

"The system shall deploy the ablative armor when encountering Borg, encountering gravitational anomalies within 6 light years of a starbase, or under attack by the Dominion."

Grouping Conditions Separately:

"The system shall deploy the ablative armor under the following conditions: when encountering Borg, when encountering gravitational anomalies within 6 light years of a starbase, or when under attack by the Dominion."³²

Asking the model to check its own results

The best move for 'O' is to take position 5, the center of the board. This is the optimal move as it blocks 'X' from having a chance to win in the next move through the diagonal (positions 3, 5, 7). The updated board would look like:

markdown

```
X | 0 | X  
-----  
- | 0 | -  
-----  
X | - | 0
```

Copy code

The numbers corresponding to the board positions would look like:

mathematica

```
1-X, 2-0, 3-X, 4-empty, 5-0, 6-empty, 7-X, 8-empty, 9-0.
```

Copy code

Regenerate

BA I'll take position 4 for X

Alright, if 'X' is placed in position 4, the board now looks like this:

markdown

```
X | 0 | X  
-----  
X | 0 | -  
-----  
X | - | 0
```



The numbers corresponding to the board positions would look like:

mathematica

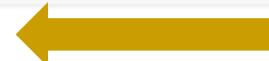
```
1-X, 2-0, 3-X, 4-X, 5-0, 6-empty, 7-X, 8-empty, 9-0.
```

With this move, 'X' has created two possible winning lines (vertical and diagonal), and 'O' must block one of them in the next move.

BA Is the game over

My apologies for the oversight. Yes, you're correct. The game is indeed over. With the placement of 'X' in position 4, 'X' has three in a row vertically on the leftmost column (positions 1, 4, 7). This is a winning condition for Tic-Tac-Toe.

Here is the final board for clarity:



Learn how to “talk” to LLMs through practice

How Do We Get Started? Three Ways...

- Look for latent talent
 - Skills may **already exist** in the organization
- Think about **embedding** DE skills in your projects
 - NASA JPL has taken this far
- Upskill engineers

Excel with Python for Engineers (4hrs)

- Just want you need to know for to import Excel, do some data manipulation, then output as Excel
- A **gateway** to the capabilities of Python for data science and AI
- **Python Data Science Handbook**,
Jake VanderPlas (open sourced)



image generated by the author

Let's Proceed Step by Step

- Explain as you would to an intelligent but inexperienced human
- Step by step instructions are very helpful
- Use delimiters to differentiate instructions from source material

```
text = f"""
In a charming village, siblings Jack and Jill set out
a quest to fetch water from a hilltop \
well. As they climbed, singing joyfully, misfortune \
struck—Jack tripped on a stone and tumbled \
down the hill, with Jill following suit. \
Though slightly battered, the pair returned home to \
comforting embraces. Despite the mishap, \
their adventurous spirits remained undimmed, and they
continued exploring with delight.
"""
```

```
# example 1
prompt_1 = f"""
Perform the following actions:
1 - Summarize the following text delimited by triple \
backticks with 1 sentence.
2 - Translate the summary into French.
3 - List each name in the French summary.
4 - Output a json object that contains the following \
keys: french_summary, num_names.

Separate your answers with line breaks.
```

```
Text:
```
{text}
```
"""
```

```
response = get_completion(prompt_1)
print("Completion for prompt 1:")
print(response)
```



International Council on Systems Engineering
A better world through a systems approach